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ASSESSING INFORMATION SYSTEM DESIGN THEORY IN PERSPECTIVE: HOW USEFUL WAS OUR 1992 INITIAL RENDITION?

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ABSTRACT

More than a decade has passed since the publication of the first article on building information systems design theories (ISDT) that appeared in Information Systems Research (Walls, Widmeyer, and El Sawy, 1992). Using the context of designing vigilant executive information systems, it articulated how to construct and test an ISDT that could prescriptively guide the design of a particular class of information system. The paper argued that successful construction of ISDTs would create an endogenous base for theory in the IS discipline, and could be used by scholars to prescribe design products and processes for different classes of information systems as they emerged.

This paper reviews ISDT and assesses how it has been used by IS scholars since that 1992 publication. It attempts to determine how useful the Walls et. al. ISDT has been in guiding design and helping theoretical development. The paper assesses the extent and practicality of its use as a theory building framework, and draws on samples of the various IS scholars have taken advantage of it in 26 papers to-date. The paper diagnoses the reasons for the limited use of ISDT and

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makes recommendations for enhancing its usability and adoption in the IS research community.

A BRIEF PERSONALIZED HISTORY OF INFORMATION SYSTEMS DESIGN THEORY – PART 1

Build it and they will come. Or so we thought --- when we published what we believe to be the first article on constructing information systems design theories. The article was titled "Building an Information System Design Theory for Vigilant EIS" and appeared in 1992 in the IS field's top journal *Information Systems Research*. Using the context of designing vigilant executive information systems, it articulated how to construct and test an Information Systems Design Theory (ISDT) that could prescriptively guide the design of a particular class of information system. The paper argued that successful construction of ISDTs would create an endogenous base for theory in the IS discipline, and could be used by scholars to prescribe design products and processes for different classes of information systems as they emerged. The paper received very favorable reviews from referees while in the reviewing cycle (which is rare) and the revisions requested were minor. We were proud of our paper and its contribution, and we thought we had set the stage to show other scholars how to build design theories for different types of information systems, and had provided a foundation for strengthening the endogenous base for theory development in the IS research community. The deluge never came, but rather it was fairly limited use. True, each of the three authors embarked on other pursuits and none of us actively evangelized about the virtues of ISDT, but then we presumably also thought that a well-placed journal article in the flagship *Information Systems Research* would be noticed by serious scholars if they needed to take advantage of it. Our most recent literature search shows 26 articles that have used this paper and ISDT in the 12 year span since it was published.

A BRIEF PERSONALIZED HISTORY OF INFORMATION SYSTEMS DESIGN THEORY – PART 2

Triggered by the editor of this special issue, we started to examine how ISDT (and especially ours) had been used by IS scholars in the last dozen years. We sought to answer the questions: How useful are ISDTs? How useful was the Walls et. al. rendition of ISDT? (especially that it seemed to be the very first). Is design theorising practically possible, and does it differ from other types of theory? Why has the use of ISDTs (mostly ours) been limited? Are they just formalisms or do they help provide new insights? Are they too cumbersome and unwieldy to work with? What is the next step in advancing ISDTs?

We were further triggered by an excellent article titled "Design Science in Information Systems Research" in the March 2004 issue of *MIS Quarterly* (Hevner, March, Park, and Ram, 2004). That article also laid out the design science paradigm and theories around building and evaluating IT artifacts, and articulated what constituted good design science research. To our chagrin, the authors were unaware of our ISDT work until it was drawn to their attention late in the cycle, even

CONTRIBUTION

- The paper provides a review of information systems design theory (ISDT) and the design science paradigm in information systems.
- The paper gives an assessment of the extent of use and practicality of the Walls, Widmeyer, and El Sawy ISDT approach as a theory building framework and a diagnosis of their modes of use by scholars from a sample of 26 papers.
- The paper makes recommendations for enhancing usability and adoption of ISDTs in the IS research community.

though one of their exemplars used ISDT through our paper. This gave us more food for thought: Was ISDT in general, and our rendition in particular as described in our 1992 paper difficult to grasp to start with? Did ISDTs also require implementation strategies for effective adoption? This paper seeks to find those answers.

Thus while there is a personalized history to our involvement with ISDT, we are seeking general answers. The initial draft of this paper made little distinction between all ISDTs and the Walls, Widmeyer, and El Sawy ISDT (after all we believed and were told that we had the first comprehensive article in 1992 in the IS community). A reviewer for this journal wisely let us know our paper and analysis seemed to be about *our* ISDT rather than *all* ISDTs. This revision is more aware of that distinction and we do assess the usability of our ISDT in particular, but examine ISDT in general as well.

The remainder of the paper is organized as follows: First, ISDT is reviewed and its relationship to design science examined. Second, the paper assesses how the Walls et . al. initial rendition in 1992 of ISDT has been used by IS scholars since then. It attempts to determine how useful ISDT has been in guiding design and helping theoretical development. The paper assesses the extent and practicality of its use as a theory building framework, and how various IS scholars have taken advantage of it. Third, and finally, the paper diagnoses the reasons for the limited use of ISDT and makes recommendations for enhancing its usability and adoption in the IS research community.

A Review of Information Systems Design Theories (ISDTS)

We first recognized the need for IS design theory when in the early 1990's we were studying Executive Information Systems (EIS). During our research, we (re)discovered something that Herbert Simon had written ten years earlier:

> *"...The professional schools will reassume their ... responsibilities just to the degree that they can discover a science of design, a body of intellectually tough, analytic, partly formalizable, partly empirical teachable doctrine about the design process..." (Simon, 1981)*

Motivated by this admonition, we fleshed out the idea of an ISDT and proceeded to propose one for "Vigilant Information Systems" (Walls, Widmeyer and El Sawy, 1992). Such systems were intended to enable executives to be "alertly watchful" for changes in the business environment that might impact strategic decision-making. At that time, we also exhorted others in the IS academic community to further develop the additional ISDT concept.

Our paper distinguished between natural and social science theories and design theories. The goal of a scientific theory is to understand or predict natural phenomenon (Dubin 1978, p. 8), while the purpose of a design theory is to guide artifact creation. We posited that design theories should be based on natural and social science theories (referred to as kernel theories) since the "laws" of the natural and social world govern the components that comprise an information system. Furthermore, design theories should be subject to the same empirical validation as other theories – that is, a design theory should have testable hypotheses. This positions *our* concept of a design theory within a normative scientific discourse as opposed to the interpretative, the critical or the dialogic perspectives (Deetz 1996).

Since "design" is both a noun and a verb, design is both a product and a process. As a product, a design is "a plan of something to be done or produced"; as a process, to design is "to so plan and proportion the parts of a machine or structure that all requirements will be satisfied". Thus a design theory must have two aspects - one that deals with the product of design and one that deals with the process of design. Obviously, these aspects cannot be entirely independent, since the design process must yield the product to be designed.

We first discuss the design theory aspect that concerns the design product. The first component of this aspect is a set of meta-requirements that describe the class of goals to which the theory applies. We use the term "meta-requirements" rather than simply requirements because a design theory does not address a single problem but a class of problems. The second component is a meta-design which describes a class of artifacts hypothesized to meet the meta-requirements. We use "meta-design" because a design theory does not address the design of a specific artifact (e.g., the Knowledge Management System at Acme Corporation) but a class of artifacts (e.g., all Knowledge Management Systems). A third component is a set of kernel theories from natural or social sciences that govern design requirements. The final component is a set of testable design process hypotheses that can be used to verify whether the meta-design satisfies the meta-requirements.

The design process is the second aspect of a design theory. The first component of this aspect is a design method that describes procedures for artifact construction. Another component is a set of kernel theories from the natural or social sciences governing the design process itself. These kernel theories may be different from those associated with the design product. The final component is a set of testable design process hypotheses that can be used to verify whether or not the design method results in an artifact that is consistent with the meta-design. The components of an information system design theory (ISDT) are summarized in Table 1. The relationships among these components are depicted in Figure 1.

Table 1. Components of an Information System Design Theory (ISDT)

Design Product		
1.	Meta-requirements	Describes the class of goals to which the theory applies
2.	Meta-design	Describes a class of artifacts hypothesized to meet the meta-requirements
3.	Kernel theories	Theories from natural or social sciences governing design requirements
4.	Testable design product hypotheses	Used to test whether the meta-design hypotheses satisfies the meta-requirements
Design Process		
1.	Design method	A description of procedure(s) for artifact construction
2.	Kernel theories	Theories from natural or social sciences governing design process itself
3.	Testable design process hypotheses	Used to verify whether the design hypotheses method results in an artifact which is consistent with the meta-design

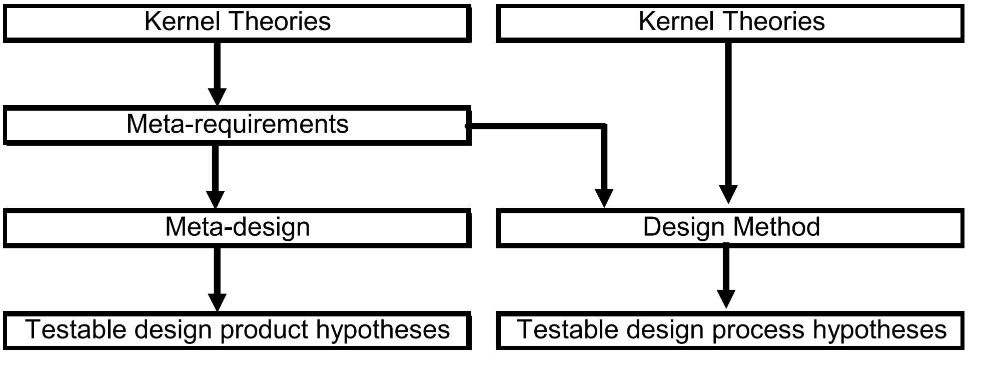

Figure 1 – Relationships Among ISDT Components

Relational database theory (Codd, 1970) may be used to illustrate the components of a design theory. The meta-requirements are the elimination of file insertion, update, and deletion anomalies. A meta-design consists of a set of tables in third (or higher) normal form. Testable design product hypotheses typically take the form of theorems and proofs. A normalization procedure would be a design method. Relational algebra would be a kernel theory for the design method. Testable design process hypotheses would be concerned with showing that the normalization method results in normalized tables.

Figure 2 from Walls, Widmeyer, and El Sawy (1992) depicts how descriptive empirical research on issue tracking and normative theories of open loop control form the basis for an ISDT for Vigilant Information Systems. The figure reflects how an ISDT goes beyond descriptive and normative theories to provide specific guidance to the design process through a prescriptive mode. Design theories are prescriptive, where natural and social science theories are descriptive.

Design Theory and Design Science

In the mid-1990s IS researchers started to show a growing interest in the topic of information system design. For example, March and Smith (1995) contrasted "design science" and "natural science" research in information systems. Others built on these ideas and took a design science approach to e-commerce research (Au, 2001; Ball, 2001). In a more recent paper, Hevner, March, Park, and Ram (2004) further developed the design science paradigm. ISWorld now has a web site devoted to "Design Research in Information Systems".

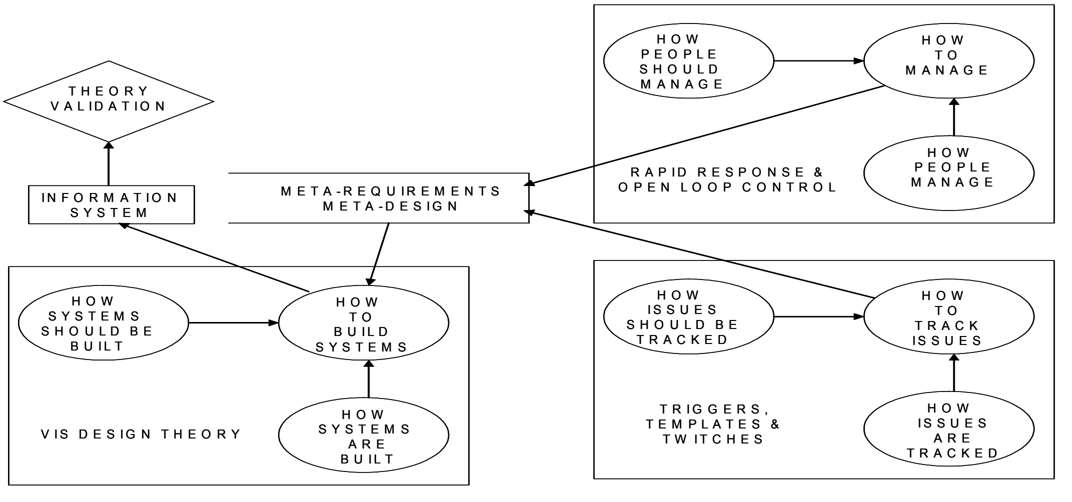

Figure 2. Design Theory for Vigilant Information Systems

Table 2. Information Systems Research Framework of March and Smith

		Design Science Research Activities		Natural Science Research Activities	
		Build	Evaluate	Theorize	*Justify*
Research Outputs	Constructs				
	Models				
	Methods				
	Instantiations				

From the perspective of these researchers, natural science is aimed at understanding reality and consists of creating and justifying theories. In contrast, "design science attempts to create things that serve human needs" (March and Smith 1995, p. 253). The latter involves building and evaluating: (1) constructs ("concepts with which to … characterize phenomenon"), (2) models (that "describe tasks, situations, or artifacts"), (3) methods ("ways of performing goal directed activities"), and (4) instantiations ("physical implementations intended to perform certain tasks"). The table above summarizes this view of the relationship between design science and natural science in the context of information systems research.

March and Smith (1995) also assert that "(n)otably absent from the list are theories…" (March and Smith 1995, p. 253). Our position is somewhat different. We contend that design practice creates "things that serve human needs", while design science should create the theoretical foundations for design practice. Our view would appear to be supported by other contributors to the design science field. For example, "design science makes a contribution of theory in business school research" (Ball, 2001, p. 2).

Figure 3 depicts our view of the relationship between natural science, design science, and design theory. Using observation and experimentation, the natural science process extracts data from the environment to create theories that become part of the knowledge base of the scientific community. The design science process selects from among these theories and combines them with characteristics of existing artifacts and the goals of actors in the environment to create new design theories. These become part of the design science knowledge base and are used in the design and construction processes to create new or modified artifacts. The properties of these artifacts become input into the next round of theory development.

Thus we do not see our view of design theory to be in conflict with the design science perspective but rather complementary to and an integral part of that perspective.

Design Theory and the IT Artifact

Another topic that has received much attention recently in the IS literature is whether study of the "IT artifact" ought to be at the core of IS discipline (Orlikowski and Iacono, 2001; Benbasat and Zmud, 2003). An artifact is "a (hu)man-made object", "an object produced or shaped by human craft", or "any object or process resulting from human activity". The word derives from the Latin words *ars* (skill) and *facio* (to make). Thus artifacts include the paintings our children make in pre-school, Michelangelo's *David,* Thoreau's *Walden,* the Golden Gate Bridge, an Intel chip, the Apple Macintosh, and SAP.

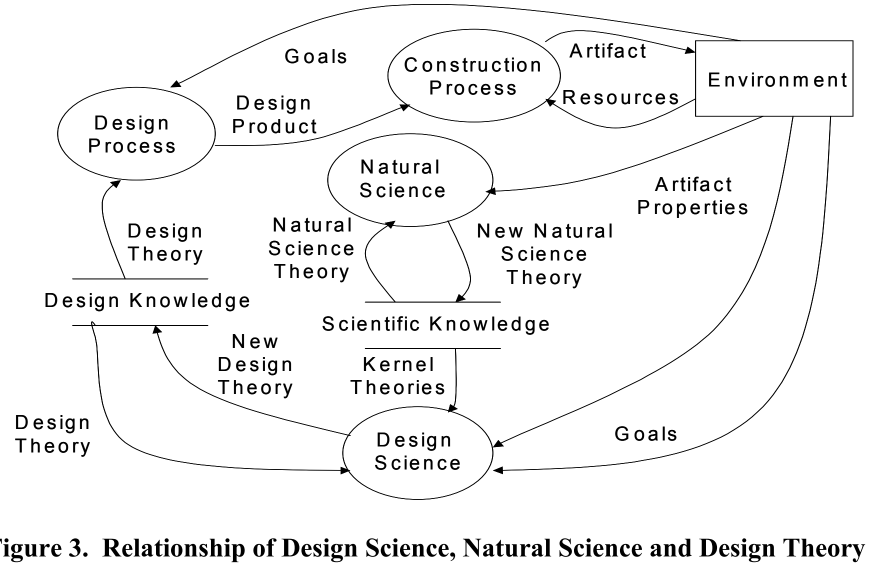

Figure 3. Relationship of Design Science, Natural Science and Design Theory

Unlike our preschoolers, engineers apply science to the design of artifacts (e.g., computers, automobiles, bridges, and airplanes). They are trained in physics and chemistry (and more recently in biology) because these branches of science provide the knowledge of the physical world that is critical to the effective design of these artifacts. For example, the theory of circuit design used by an electrical engineer is based on mature theories of physical science. Similar statements can be made about the design of airplanes and bridges.

We used the term "artifact" quite liberally in our 1992 paper. The first occurrence was on second page: "The design process is analogous to the scientific method in that a design, like a theory, is a set of hypotheses and ultimately can be proven only by construction of the artifact it describes." (We believe that we actually adopted the term artifact from Sciences of the Artificial (Simon 1969).) We said that "(t)he objective of a design theory is to prescribe both the properties an artifact should have if it is to achieve certain goals and the method(s) of artifact construction." (p 41) We did not use the current phrase "IT artifact", but in essence it was that to which we were referring.

Alter argues that rather than the "IT artifact" the core of our discipline should be "IT-enabled work systems" (2003). Work systems produce products or services for customers and are composed of human participants, information, technology, work practices, products, customers, strategies, infrastructures, and the environment (see Figure 4). Alter goes on to define an information system to be a special type of work system that produces information.

The only elements of a work system that are not "human-made" (artifacts in the sense of the dictionary definition) are the participants and the customers. It could even be argued that these elements are human-made in the sense that their education, training, and culture derives to a great extent from the "art" of their parents, teachers, coaches, peers and managers. Even much of the environment is human-made.

Table 3

Work System Element	Designed?
Information	Yes
Technology	Yes
Participants	No
Work Practices	Yes
Products and Services	Yes
Customers	No
Environment	No (?)
Strategies	Yes
Infrastructure	Yes

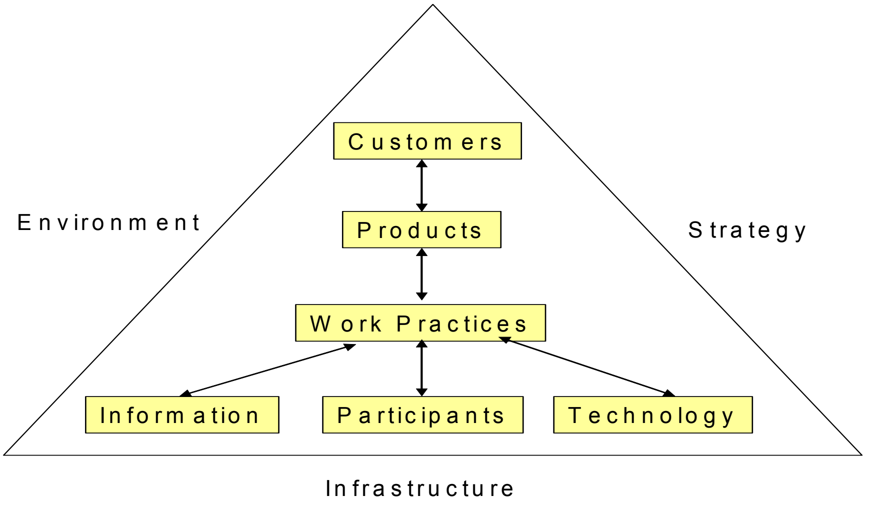

Figure 4 – The Work System Framework (adapted from Alter, 1999)

Thus designing an IS involves designing products, work practices, information, and technology. Information (reports, dialogs, forms, messages, etc.) is the product of the IS. Work practices are the steps performed by the participants (procedures) and the technology (software) required to produce the information. The information used by the participants in the work practices consists of the data provided by participants together with related databases. Information system design theories support the design of these components and their relationships.

Whether we take the perspectives of Benbasat and Zmud (2003) or Alter (2003), it is clear that many of the elements of an information system are artifacts (i.e., human-made) and are therefore designed. The basic premise behind ISDT is that the IS field, like the engineering disciplines, needs to develop design theories for IT artifacts (the part of an IS that is designed) that are firmly grounded in natural and social science theory.

Is Design Theory Possible?

Hooker (2003) poses the above question and proceeds to argue, primarily on philosophical grounds, that the answer is "No". He defines design to be the "passage from a functional description to a physical description of an artifact" (there's that word again!) He says that "(k)nowledge of how to design cannot be reduced to theory, for reasons that grow out of the philosophy of science." He also observes that a "fundamental fact about design that complicates theoretical treatment is that design is a practice" and that design theory "must therefore organize our knowledge of design practice". (p. 4) Following Aristotle, Hooker mentions three types of knowledge - *techne* (know how), *episteme* (theoretical knowledge), and *phronesis* (judgment). "Judgment is where theory and practice meet", he says. He agrees with Habermas (1975) by concluding that "practical knowledge is logically prior to theoretical knowledge, and that it makes no sense to speak of understanding practice theoretically." (p. 7)

On the contrary, we would of course argue that design theory is possible. In our paper, for example, we cited relational database theory as a well developed design theory. It provides an existence proof that design theory *is* possible. We also proposed a design theory for vigilant EIS, as well as suggestions for testing the theory. Others have provided design theories for a variety of types of information systems, which we discuss in the next section of the paper.

Ultimately Hooker does open the door to the possibility that design theory might exist.

> *"A characteristic and remarkable trait of design is that it deals with incompletely described objects…This suggests a type of theory that may be unique to design. Whereas science normally studies real, concrete objects, design science would study the properties and behavior of incompletely described objects."* (p.10)

This statement is consistent with our definition of meta-requirements and meta-design, which deal with a class of information system rather than a specific instance of one.

He also draws from the field of medicine to suggest that design theories may be like medical theories which are teleological.

> *"Teleological explanation orders experience by assigning a purpose or function to its components…. Teleological theories also make testable predictions."* (p. 13)

For example, a medical researcher might predict what a body part does and observe situations where it is removed to see if the prediction is true. Again, this idea is consistent with our notion of a design theory which includes testable hypotheses about the designed artifact which does perform a function.

Assessing the Use of Our ISDT Approach By IS Researchers

We identified twenty six articles that referenced Walls, Widmeyer, and El Sawy (1992). (A complete list of articles is available from the authors.) Of those, we found four that in our judgment used the ISDT concept extensively in their research: Stein and Zwass (1995); Kasper (1996); Markus et. al (2002), and Hall et. al (2003). We examined these articles in order to answer the following questions:

- How and why the authors adopted the ISDT concept in their research?
- How well did it work? How usable was it?
- What difficulties, if any, did they encounter in using the concept?

We review the earlier two of these papers below in detail to show how ISDT was used, and then we also utilize the later two of these articles in the last section of this paper to assess usability.

The Stein & Zwass Use of ISDT: Organizational Memory Information Systems

Stein and Zwass (1995) developed a design theory for an Organizational Memory Information System (OMIS) which they defined to be "a system that functions to provide a means by which knowledge from the past is brought to bear on present activities, thus resulting in increased levels of effectiveness for the organization." Their layered design theory has two kernel theories. The upper layer is based on the competing values model of organizational effectiveness (Quinn and Rohrbaugh, 1983) and the lower layer on the information processing model of memory (Atkinson and Shiffrin, 1968).

The competing values model evolved from an empirical study of over forty organizational theorists and researchers who were asked to make pair-wise similarity comparisons within a set of thirty organizational effectiveness measures (e.g., efficiency). Factor analysis showed that the measures clustered along three dimensions: emphasis on flexibility versus control, internal versus external focus, and concentration on means versus ends. Using the titles of well known organization models (Scott, 1999, p. 72), labels were assigned to items clustered into each quadrant of a two dimensional space defined by the flexibility-control and internal-external dimensions. Quadrants were identified with the Rational Goal Model (focusing on productivity and efficiency); the Human Relations Model (focusing on morale and cohesion); the Open Systems Model (focusing on adaptation and resource acquisition); and the Internal Process Model (internal control). Figure 4 depicts where each model occurs in the 2d space.

As shown in Figure 5, the quadrants also map to the organizational functions identified by Parsons' (1965) – the pattern maintenance function, the adaptive function, the integrative function, and the goal attainment function. The OMIS design theory asserts that each of Parson's four organizational functions must have access to

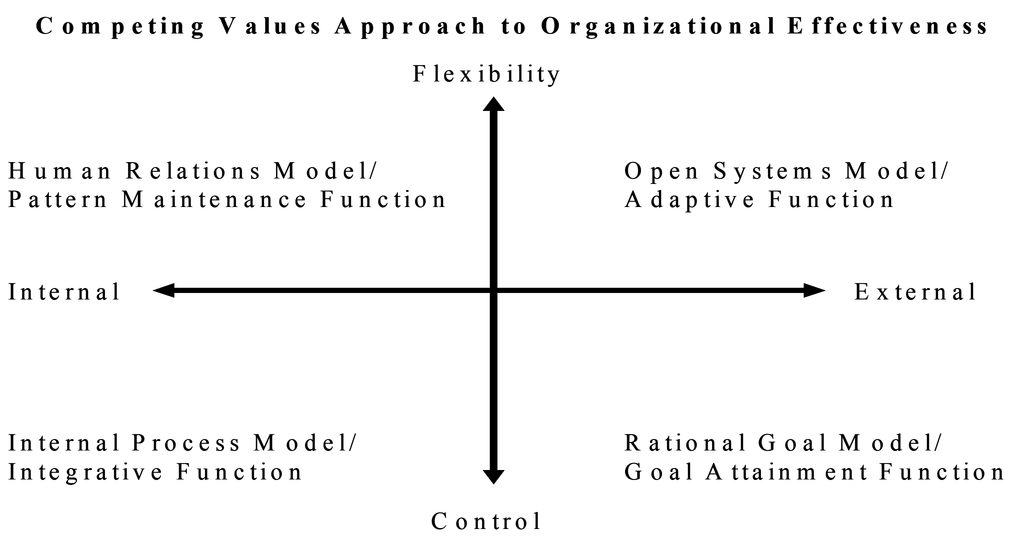

Figure 5

organizational memory and therefore the subsystems of an OMIS should support these functions. The design theory proposes meta-requirements and a meta-design for each organizational function. For example, "the *meta-requirements* of the adaptive subsystem include boundary spanning activities to recognize, capture, organize, and distribute knowledge about the environment to the appropriate organizational actors." (p. 100) The authors provide examples of existing technologies that at least in part support the meta-requirements of the OMIS design theory.

Different organizations have different competing value profiles. Tools have been developed for assessing this. Based on this, different organizations would need different OMIS features. (This is a contingency approach.) Parson's theory says every organization needs to do these functions (true) but because there are competing objectives, you can't do everything at once or everything well (it has been said that companies focus on different goals at different times). Part of theory could be diagnosis.

The information processing model of memory is the second kernel theory of the OMIS design theory. Using this model, the processes of memory are information acquisition, retention, maintenance, search, and retrieval (Stein and Zwass, 1995). A *meta-requirement* corresponding to the acquisition process is to provide a means of transferring information into memory. A component of the *meta-design* is an information filtering function.

The fit between the OMIS design theory and the conception of an ISDT provided earlier is highlighted in Table 4. From this table it is clear that no design process was included in the theory. Further, there were no clearly articulated testable design process or product hypotheses presented. Thus there is opportunity for further development of the OMIS design theory.

The Kasper Use of ISDT: Decision Support Systems for User Calibration

Kasper (1996) proposed an ISDT prescribing properties of a decision support system (DSS) that would achieve the goal of perfect user calibration – a condition where a user's confidence in a decision supported by the system would be equal to the quality of that decision. In other words, the user should believe neither that a poor decision is good nor that a high quality decision is inferior. To improve calibration, a DSS should not only help the user make a decision but also help the user assess how good a decision she or he has taken.

Since user calibration depends on the decision maker's mental representation of a problem, the primary kernel theories underlying the design theory for user calibration address mental (Gigerenzer, Hoffrage, and Kleinbolting, 1991) and symbolic (Kaufman, 1985) representation of a problem. Mental representation depends on memory (or knowledge) and inference (or syllogistic reasoning). The theory of symbolic representation proposes three "symbols and methods of reasoning":

1) linguistic representation, corresponding to conventional knowledge;
2) visual representation, facilitating a holistic perspective on a problem; and

Table 4. OMIS Design Theory

		Theory Component	Examples
Design Product	1.	Meta-requirements	Boundary spanning capabilities
	2.	Meta-design	Information filtering
	3.	Kernel theories	Competing Values Approach, Information Processing Model of Memory
	4.	Testable design product hypotheses	??
Design Process	1.	Design method	?
	2.	Kernel theories	?
	3.	Testable design process hypotheses	?

3) exploratory reasoning, generating new mental models based on hypotheses.

In moving from 1 to 3 individuals increasingly rely on inference over memory in solving a problem. Because inference is less reliable than memory, user calibration decreases as the inference component of a mental model increases. For a user to be able to assess the quality of a decision, the DSS should be designed in a way that supports his or her way of thinking about the problem.

Problem novelty refers to how new a problem is to the decision maker. As problem novelty increases, the locus of problem representation shifts from 1 to 3. The design of a DSS should correspond to the problem representation appropriate to problem novelty.

The design theory for user calibration asserts that the symbols and actions (i.e., computer dialog) of a DSS should parallel the user's representation of a problem. The theory articulates system properties of expressiveness, visibility, and inquirability, corresponding to linguistic representation, visual imagery representation, and exploratory reasoning respectively (see Table 5). The expressiveness of a DSS refers to the manner in which it presents information to the user (matter-of-fact, condescending, supportive, or directive) and impacts feelings of confidence. The visibility of a DSS corresponds to the extent to which it helps the user understand how the system works. The inquirability of a DSS refers to the nature of the user dialog – does the system confirm the user's decision (is it servile) or challenge it (is it contrarian). A contrarian dialog should result in a higher quality decision. The design theory hypothesizes that user calibration can be achieved through the proper application of expressiveness, visibility, and inquirability. Furthermore, as problem novelty increases, the focus of a design should shift from expressiveness to visibility to and inquirability.

Table 6 below, taken from Kasper (1996) summarizes the design theory.

Table 5. DSS Properties and Problem Novelty

	Design Locus		
Expressiveness	High	Moderate	Low
Visibility	Low	High	Low
Inquirability	Low	Moderate	High
Novelty	Low	Moderate	High

Table 6. Components of the DSS Design Theory for User Calibration Design Product

Goal	Prescribe the requisite properties of a DSS for users to realize perfect calibration	
		Example Attributes
Design Properties	Expressiveness	Tone
		Rhetorical strategy
		Framing
		Connectiveness
		Message construction
	Visibility	Realist/abstract images
		Timing
		Alterations
		Transitions
	Inquirability	Level of dialectic
		(servile to contrarian)
Design Process		
Design Method	Locus of design varies with problem novelty	

The fit between the DSS design theory for user calibration and the conception of an ISDT provided earlier is highlighted in Table 7 below. From this table it is clear that neither a meta-design nor a design method were included in the theory. Further, there were two high level testable hypotheses presented. Thus there is opportunity for further development of this design theory as well.

What do the two papers reveal about how ISDT was used? In both the papers ISDT was used as a guiding framework and foundation and provided a way of systematically structuring the "how to" of design with a "why" foundation based on theory. It also helped generate some insights that would have remained hidden without the use of ISDT. In both the papers, it also appears that some elements of ISDT were not fully considered, and that there was room and opportunity for more development of the theories that prescriptively guided the design of these types of information systems.

One of us interviewed Vladimir Zwass in May 2004. He said that our article was an important one in the IS field. It is important because it draws into IS the idea that design is essential. The field should focus on design as well as analysis. He and Stein used the idea in their paper because an associate editor of ISR suggested that the ISDT concept be incorporated and they thought that this was a good idea. Although the concept did not help in developing the core idea of the paper, it helped in extending the paper to more realistic design issues.

ENHANCING ISDT USABILITY

The last section identifies in detail how ISDT was used in two cases, and we come to the conclusion that it is partially successful in helping to provide theory-driven design guidelines and prescriptions for IS design, and the generation of hypotheses that are testable. In this section we examine the usability of ISDT and make recommendations for enhancing its usability and ease of use. We use the other two more recent articles that have used ISDT extensively.

Usability of ISDT by Markus et. al.: ISDT for Emergent Knowledge Processes

Markus, Majchrzak, and Gasser (2002) used ISDT for providing design principles for designing IS/IT support for emergent knowledge processes (EKP). EKPs are patterns of activity in organizational environments that include emergent processes of deliberations whose sequence is unknown, has complex knowledge requirements, is ill-structured, and evolves dynamically. Basic research and new product development are typical examples of contexts in which EKP are rampant. EKP also are distributed across a dynamic set of changing actors whose roles and prior knowledge is unknown. Their premise was that EKP was a different class of information system that needed its own ISDT. They developed an EKP design theory that provided both guidelines for developers and an agenda for academic research. They also developed a manageable set of EKP design and development principles which they had

Table 7. DSS Design Theory for User Calibration

		Theory Component	Examples
Design Product	1.	Meta-requirements	DSS should possess properties of Expressiveness, Visibility, and Inquirability
	2.	Meta-design	?
	3.	Kernel theories	Psychological theories of mental and symbolic problem representation
	4.	Testable design product hypotheses	Users will achieve goal of perfect calibration to the extent that DSS has E,V,I
Design Process	1.	Design method	?
	2.	Kernel theories	Psychological theories of mental and symbolic problem representation
	3.	Testable design process hypotheses	Locus of design should vary with problem novelty from E to V to I

derived through the interplay of their experience from implementing such systems in practice, as well as trying to use ISDT in the EKP context. The extent of usability of ISDT as inferred from the paper can be interpreted as follows: there was tension at first between the design principles that they had derived from successful practice, and their initial ISDT. The paper has a table that shows the initial ISDT and the problems they encountered while attempting to apply it. This initial mismatch may be viewed as either a "bug" or a "feature" (to use that distinction first made by Markus in her classic 1979 systems design book). It can be viewed as a "bug" if it annoys the scholars in not accounting for or capturing aspects they think are true, and it is a feature of ISDT if it helps to identify mismatches which require careful attention and a regress to kernel theories. We believe it was a combination of both. To get some more insight on the usability of ISDT, one of us interviewed Ann Majchrzak, one of the authors of that paper -- in May 2004. She believed that when they started with their design principles, they were already applying design science. The ISDT as provided by Walls et. al (1992) provided a framework around which they could articulate their contributions to readers and scholarly consumers with a common agreed-upon language that was recognizable and repeatable. It also provided a useful wrapper around the methodologies for prototyping systems. However, ISDT was somewhat cumbersome to use, and while it treated both the product and process of design, it did not adequately and explicitly address the interplay of product design and process design and the intimate interactions between them.

Usability of ISDT by Hall et. al.: ISDT for Learning-Oriented Knowledge Management Systems

Hall, Paradice, and Courtney (2003) in this journal articulate an ISDT for Learning-Oriented Knowledge Management Systems (LOKMS). They develop a system architecture of eleven core modules based on using Churchman's theory of inquiring systems, and Simon's classical intelligence-design-choice model as kernel theories for ISDT. They view their contribution as showing how the development of LOKMS can be enhanced through ISDT, and also importantly showing how to address practitioner concerns during the conceptualization process. They successfully used ISDT for prescribing the meta-requirements for the product of design for LOKMS, and portions of the design process. They also generated and tested hypotheses based on that. While we did not get the opportunity to interview any of the authors, it appears that ISDT brought together a very disparate set of kernel theories and requirements in an organized conceptual framework which allowed further development with a common collective understanding between the scholars and the users of the systems. They were also able to generate new insights in the paper after using ISDT to bring all these elements together. The outcomes suggest that ISDT was usable for LOKMS, but more importantly in this case that the outcomes of the ISDT made LOKMS conceptualization more acceptable to users. This while usability of ISDT would seem to be assessed primarily for IS researchers and scholars, it also has an indirect impact on system developers and users.

What do these two papers reveal about ISDT usability? First, that ISDT is usable by scholars, and provides outcomes that enhance usability for users as well. Some scholars appear to have some gripes with how cumbersome ISDT can be and identify some of its omissions that would facilitate usability. They all the same find it convivial enough that they are willing to work through it to get the outcomes. Others, find it very usable. For example, Stein and Zwass (op. cit) report no difficulties in usability when applying ISDT to their research. We agree with both sets of opinions. For some types of systems, ISDT is more easily applied, and for others it requires more work. We also acknowledge that ISDT requires much more work in being complete and in making the exposition more palatable.

In assessing the extent of use of ISDT in the 26 articles that reference it, we have also identified four different levels of usage:

- Level 1: ISDT is used as a *cloak of theoretical legitimacy* to describe the design features and requirements of a new class of information systems. In some instances this is done at a rather superficial level (like referencing ISDT in a paragraph and how it fits). In some other instances, a more serious attempt is made to make the link. In some cases, this type of use is in response to a journal reviewer or editor suggestion.

- Level 2: ISDT is used as a *common language and framework* for determining the meta-requirements for a new class of information systems and how its instances should be designed. At that level, the IS researchers spend considerable effort working through ISDT in their own context and attempt to bring order and systematic structure to their exposition. This allows comparability across different types of systems, and is useful to cumulative design knowledge and generalizability.
- Level 3: ISDT is used as a *way of generating new insights* about the characteristics of a new class of information systems. At this level, not only is there a systematic methodology for bringing the theoretical rigor of kernel theories to guide the product and process of design (as in Level 2), but in addition to that the scholars take advantage of ISDT in generating new insights which would not have been discovered otherwise. This is the desirable level of ISDT usage that will advance the development of endogenous IS theories.
- Level 4: The *richness of ISDT itself is enhanced* through usage as scholars discover gaps and omissions and improvements that can be made to ISDT that are revealed by working through it in their own context. At that level, double loop learning from ISDT occurs and advances in theory building methodologies are made.

Most of the ISDT use has been at Levels 1 and 2, with Level 3 usage in a very few cases. There have been statements made that ISDT needs some changes, but we have not seen much evidence of Level 4 use. How can we extend and enhance both the usability and usefulness of ISDT such that it extends to the higher levels of usage? We suggest four complementary sets of strategies:

(A) Articulation Strategies: Improving ISDT exposition by better explaining its use with examples. We have tried to do some of that in this paper. We also have to recognize its complexity, difficulties and limitations. We have realized over the years that when we use the 1992 ISDT paper in doctoral seminars, that it is hard work for the readers to work through it. It is not always easy to cognitively bring together the various parts that comprise ISDT in one attempt. Simpler exposition and better articulation in an easy-to-read format will help usability by researchers and developers.

(B) Tool-Kit Strategies: Providing researchers with computer-based templates, repositories of examples, and frequently asked questions around building ISDTs, might be a more effective way of helping with the implementation of ISDT. This could provide different types of interactions for researchers and developers. One could envisage a researcher tool kit, a developer toolkit, and a system user toolkit as well.

(C) Augmenting the Structure of ISDTs: We hope that other IS scholars will be encouraged through this article to re-examine the structure of ISDT and enhance its usability through a better structure. This could be through richer interactions between the components, or standard modularization with inter-changeability, or other creative additions. One criticism of ISDT is that it does not provide much guidance in identifying kernel theories. This is unfortunate, but we believe that this is where the creativity and innovativeness of the design scientist comes into play. No one told Einstein that tensor algebra was the answer to his problem of developing the general theory of relativity. (We never said it would be easy!)

(D) ISDT Evangelism: There is a need to spread the word about design science and ISDT as it is under-represented in the IS academic community and in our journals. This issue is a big step in that direction, as is the recent emphasis at the journal *Information Systems Research* and ICIS in encouraging that genre of work. It is one of the few research paradigms in the information systems field that is endogenous to the field itself.

Indeed, while we can also say that there is nothing so practical as a good "theory building tool-kit" for scholars – it too requires a strategy for informing them of its capabilities and benefits. Theory building tool-kits for developing and testing ISDTs -- like the information systems artifacts they help to eventually create – also require effective implementation strategies for effective adoption – and perhaps even methodological evangelism. We believe this holds true whether it is the "Walls, Widmeyer, and El Sawy" ISDT, or any other one.

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